Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of

Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands	)	WT Docket No. 12-70
Fixed and Mobile Services in the Mobile Satellite Service Bands at 1525-1559 MHz and 1626.5-1660.5 MHz, 1610-1626.5 MHz and 2483.5-2500 MHz, and 2000-2020 MHz and 2180-2200 MHz	)	ET Docket No. 10-142
Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands	)	WT Docket No. 04-356

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I respectfully submit this comment in response to the Federal Communications Commission's ("FCC" or "Commission") Notice of Proposed Rulemaking on Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands in the above-captioned dockets ("Proceeding").[1]

I. Introduction

I commend the Commission for raising the question of receiver performance in this Proceeding. The full benefit of radio operations can only be obtained if regulation considers transmitters and receivers together as a system. Since receivers have traditionally been omitted from consideration, this proceeding provides a critical opportunity to develop forward-looking spectrum policy that comprehensively addresses the need for more wireless services.

There is an emerging consensus that regulation needs to acknowledge the role of receivers as a constraint on the deployment of new services. The FCC has shown commendable foresight by laying the groundwork over recent years. The important role of receiver performance was recognized in the FCC's Spectrum Policy Task Force Report (2002),[2] and addressed by the Notice of Inquiry "Interference Immunity Performance Specifications for Radio Receivers" (2003).[3] The 2009 Notice of Inquiry "Fostering Innovation and Investment in the

[1] Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 Bands; Fixed and Mobile Services in the Mobile Satellite service Bands at 1525-1559 MHz and 1626.5-1660.5 MHz, 1610-1626.6 MHz and 2483.5-2500 MHz, and 2000-2020 MHz and 2180-2200 MHz, Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands, *Notice of Proposed Rulemaking and Notice of Inquire*, WT Docket No. 12-70, ET Docket No. 10-142, WT Docket No. 04-356 (2012).

[2] Spectrum Policy Task Force Report, ET Docket No. 02-135, November 15, 2002. The Spectrum Policy Task Force Report of the Interference Protection Working Group recommended that FCC needed to shift the focus onto receiver characteristics. "The Working Group believes that receiver reception factors, including sensitivity, selectivity, and interference tolerance, need to play a prominent role in spectrum policy."

[3] Interference Immunity Performance Specifications for Radio Receivers; Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television, *Notice of Inquiry*, 18 FCC Rcd 6039 (2003).

Wireless Communications Market" also requested comment on the role of receivers in interference management.[4] Last but not least, the Commission demonstrated commendable foresight by organizing a workshop on the topic of "Spectrum Efficiency and Receiver Performance" in March 2012.[5] Finally, recent legislation passed by Congress calls for a study of receiver performance and the potential for making more efficient use of spectrum by imposing some type of regulation on receiver performance.[6]

In this comment I will argue that receiver performance affects the allocation of spectrum and opportunities for the creation of new services; that receiver management does not necessarily mean imposing receiver standards; that the Commission should define interference limits, an explicit statement of the radio interference level that a licensee's system needs to tolerate, for AWS-4 licenses; but that receiver performance standards need not be specified in this service.

II. Receiver performance affects the allocation of spectrum and opportunities for the creation of new services

In order to address the growing demand for wireless services, the number of radio systems that operate close together in frequency, space and time needs to increase. However, greater proximity increases the risk of service failure due to harmful interference. As the FCC pointed out in the Public Notice for its March 2012 workshop, "Receiver performance issues have often arisen as a conflict between legacy stakeholders and new entrants where deployment

[4] Fostering Innovation and Investment in the Wireless Communications Market; A National Broadband Plan For Our Future, *Notice of Inquiry*, GN Docket No. 09-157, ¶ 36 (2009).

[5] FEDERAL COMMUNICATIONS COMMISSION, *Workshop on Spectrum Efficiency and Receivers (Day 2)*, http://www.fcc.gov/events/workshop-spectrum-efficiency-and-receivers-day-2 (last visited 5/14/12).

[6] Middle Class Tax Relief and Job Creation Act of 2011, H.R. 3630, 112th Congress 1st Session, December 13, 2011. In particular see: Section 6408: Study on Receiver Performance and Spectrum Efficiency.

of new technologies and services threatens to adversely impact an incumbent or place restrictions on the new entrant."[7]

Successful operation of a wireless service is a system design challenge, and requires balancing receiver and transmitter characteristics. Harmful interference can be due to either poor interference tolerance in receivers and/or inappropriate signals radiated by transmitters. However, regulation has customarily just attended to transmitters, thus ignoring half of the system design problem. The need to pack wireless services ever more closely together requires more regulatory attention to receivers.

The AWS-3 proceeding has demonstrated that ambiguity about the level of interference that will be permitted in bands adjacent to auctioned licenses can lead to a great waste of resources over a long time. [8] If such problems are to be avoided in future, the Commission needs to provide explicit, quantitative statements of the interference that licensees need to tolerate from services in adjacent bands.

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[7] *FCC Public Notice*, Office of Engineering and Technology, Wireless Telecommunications Bureau, and Office of Strategic Planning Announce Workshop on "Spectrum Efficiency and Receiver Performance," DA 12-378, rel. March 9, 2012.

[8] **November 2003** — Commission indicates a willingness to revisit whether to allow TDD in the AWS-1 band, as well as intention to provide for TDD in the AWS-3 Band; see Service Rules for Advanced Wireless Services in the 1.7 and 2.1 GHz Bands, WT Docket No. 02-353, *Report and Order*, 18 FCC Rcd 25162, ¶ 46 (2003) ("*AWS-1 Report and Order*"). **May 2006** — M2Z submits a license application to the FCC to utilize the 2155-2175 MHz band; s*ee* M2Z Ex Parte Presentation in Service Rules for Advanced Wireless Services in 2155-2175 MHz, *Notice of Proposed Rulemaking*, 07-195 (2008), *available at* http://fjallfoss.fcc.gov/ecfs/document/view?id=6520012275. **September 2007** —FCC issues an NPRM for the 2155-2175 MHz band and asks for comments on the proposed service rules. See Service Rules for Advanced Wireless Services in 2155-2175 MHz, WT Docket No. 07-195, *Notice of Proposed Rulemaking*, 22 FCC Red 17035 (2007). **August 2010** — Commission terminates the AWS-3 rulemaking, see FCC Terminates AWS-3 Rulemaking to Auction Spectrum with Free Broadband Requirement; Breaks National Broadband Plan Commitment, PR NEWSWIRE, http://www.prnewswire.com/news-releases/fcc-terminates-aws-3-rulemaking-to-auction-spectrum-with-free-broadband-requirement-breaks-national-broadband-plan-commitment-101967093.html.

As Evan Kwerel and John Williams have pointed out, new allocations must avoid encumbering adjacent bands targeted for flexible use.[9] Under the current first-in-time policy of harmful interference protection, a licensee next to a currently radio quiet band can assume that its receivers will be protected indefinitely against higher signal levels, thus precluding more intensive use of the adjacent band. A mechanism that puts incoming licensees on notice that they will have to tolerate higher interference in future would facilitate reallocation to more valuable uses. The interference limits approach described next is one way to do so.

III. Receiver management does not necessarily mean imposing receiver standards

While it is now commonly accepted that radio regulation should take reception as well as transmission into account, an effective way to do so has remained elusive.

Discussion to date has focused on receiver performance specifications imposed by the regulator, often called receiver standards. While they could ensure that receivers operate satisfactorily in a given interference environment, receiver standards are controversial because they are very detailed and service-specific; because of concerns that they increase costs and constrain innovation; and because of a belief that regulators should not mandate technology standards.

[9] Pierre de Vries, *Receiver Protection Limits: A Better Way to Manage Interference than Receiver Standards*, DEEPFREEZE9, Wednesday, June 22, 2011, http://deepfreeze9.blogspot.com/2011/06/receiver-protection-limits-better-way.html; Evan Kwerel & John Williams, *Solving the Receiver Problem Without Receiver Standards*, prepared for the FCC Workshop on Spectrum Efficiency and Receiver Performance, March 13, 2012 available at http://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session6/SESSION-6-1-Kwerel-Williams-FCC.pdf; Even Kwerel & John Williams, *Forward-Looking Interference Regulation*, 9 J. on Telecomm. And High. Tech. L 501, 516 (2011) available at http://jthtl.org/content/articles/V9I2/JTHTLv9i2_DeVries.PDF.

A. The Interference Limit alternative

However, receiver standards are not the only regulatory tool available; an alternative is to specify the radio frequency interference that a radio system should be able to tolerate.[10] Operators can then use their discretion to determine the combination of receiver performance and transmission characteristics they require to ensure adequate performance in the presence of such interference, given their business model and their customers' preferences.

The receiver interference limits approach advocated here follows this path. An interference limit is a statement by the Commission, as part of an operating assignment, of the radio interference[11] that has to be exceeded before a licensee[12] can make a claim of harmful interference. [13]

An interference limit is defined as a profile of field strength density (e.g. in units of dB(μV/m) per MHz, or equivalently, dB(W/m^2) per MHz) over frequencies both in-band and out-of-band, at all locations in an operating area; an assignee can only claim harmful interference if this limit is exceeded at more than a prescribed percentage of locations and times. Where an interference limit is not defined, no protection is provided. (See Figure 1.)

[10] Nat'l Telecomm. & Info. Admin., U.S. Dep't of Commerce, TR-03-404, Receiver Spectrum Standards: Phase 1 – Summary of Research into Existing Standards, Section 7 (2003).

[11] Interference here refers to the level of radio frequency energy, and not to the effect that such energy may have on a receiving system.

[12] Or more generally, anyone with a radio operating authorization, including unlicensed and licensed by rule.

[13] Pierre de Vries, *Optimizing Receiver Performance Using Interference Limits*, prepared for the FCC Workshop on the Spectrum Efficiency and Receiver Performance, March 13, 2012 available at http://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session6/SESSION-6-3-Pierre-de-Vries-WEB.pdf.

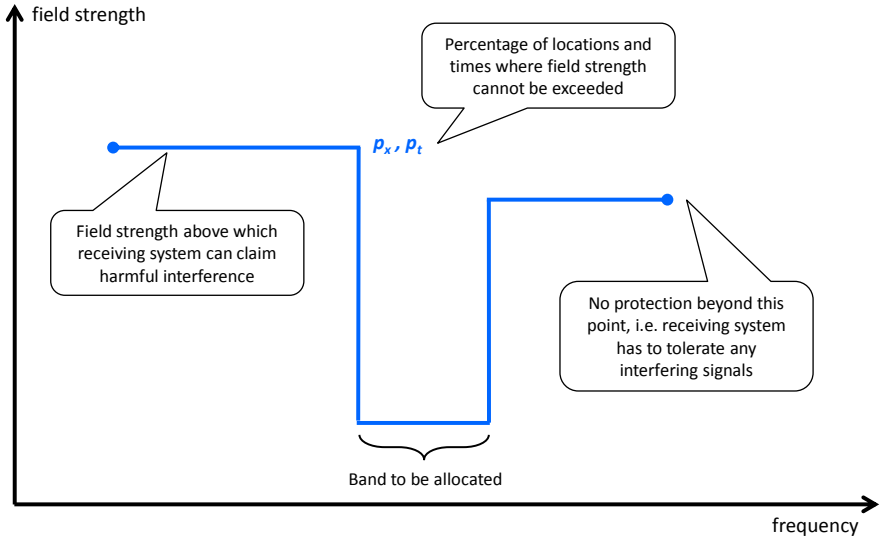

Figure 1. A generic interference limit, not drawn to scale. The field strength profile indicates the third party signal strength level that has to be exceeded (at more than the specified percentage of locations and times) before the operator in the allocated band can make a claim of harmful interference.

Receiver interference limits may not be sufficient in cases where receivers are not controlled by a license holder, particularly where there are many millions of consumer-deployed devices, or for safety-of-life systems like those used in aviation. Additional measures such as self-certification or mandated performance standards may be required to certify that such devices can operate successfully given the relevant receiver interference limits.

B. Benefits of Interference Limits

Interference limits leave decisions about radio system design, including receiver performance, in the hands of licensees. For example, a licensee can ensure successful operation either by improving the out-of-band interference rejection of receivers or by increasing the

strength of the desired signal relative to the adjacent interference, e.g. by increasing the spatial density of transmitter locations or by increasing radiated power. What counts as "success" may vary from one operator to another; for example, a service that can function with low data rates requires less adjacent channel interference rejection in its receivers, all else being equal, than one that requires high throughput. Operators would be free to deploy inexpensive receivers that suffer degradation even for interference below the limit, e.g. at the edge of coverage, if that satisfied their customers or met mission requirements. However, if an operator chose to deploy such a device, it could not make claims of interference and impose costs on services in neighboring bands that were operating within their transmission permissions.

For the receiver operator, interference limits provide an explicit guarantee that future neighboring allocations will not generate unplanned interference. A receiver operator could only make a claim for harmful interference if the aggregate signal strengths from neighbors exceeded the interference ceiling specified in the interference limit. This would prevent claims for harmful interference due to poor receiver design or insufficient received power.

Interference limits thus provide certainty to both incumbents and new entrants regarding the interference their respective systems have to tolerate, and avoid creating. This would be accomplished without the regulator having to devise performance specifications or impose technology mandates that increase the cost of all receivers regardless of their intended use.

If licenses allow parties to negotiate variances of interference limits across allocation boundaries, then the amount of interference that transmitters could cause, or receivers had to tolerate, could be changed by private negotiation. If the balance between transmitters and receivers was not at the social welfare optimum in the initial rights allocation by the FCC, or if

the optimal point changed over time with evolution in technology or business models, then such negotiations would allow parties to move to the economically efficient distribution of entitlements.

IV. AWS-4 licenses should include Interference Limits

While this Proceeding is focused on interference from AWS-4 services into other bands, the Commission also wisely requests comment about the risks of interference into AWS-4 from adjoining bands.[14]

In cases where similar services are deployed in neighboring frequency blocks, for example with cellular services, industry is usually well-placed to self-regulate interference conflicts since the parties to potential disputes use similar technologies and business models.[15]

However, significant problems can arise across allocation boundaries between dissimilar services.[16] The proposed AWS-4 allocations adjoin or are close to a variety of services with very different radio characteristics, and characteristics that may change under future re-allocations: the AWS-2 H block and the two AWS-2 J blocks; the 2025-2100 MHz band used in various terrestrial and satellite commercial services, and various federal uses such as spacecraft control and satellite services; and the 2200-2290 MHz band allocated to federal use.

[14] Proceeding, *supra* note 1, at ¶ 56.

[15] The AWS-3 proceeding suggests that industry may have trouble self-regulating interference between TDD and FDD operations.

[16] Silicon Flatirons workshop, Radio Regulation Summit: Defining Inter-Channel Operating Rules, September 8 & 9, 2009, available at http://www.silicon-flatirons.org/events.php?id=761; Silicon Flatirons workshop, Efficient Interference Management: Regulation, Receivers, and Rights Enforcement, October 18, 2011, available at http://www.silicon-flatirons.org/events.php?id=1021

These bands are currently relatively radio quiet.[17] Unless the Commission provides explicit, quantitative notification that increased interference may be generated by services in these bands in future, however, AWS-4 licensees would be within their rights to deploy receivers that could not tolerate out-of-band interference from future services in adjacent bands operating at signal levels similar to cellular systems. Interference limits offer a simple way to include this notification in AWS-4 licenses.

The values of interference limits can be calculated by reference to the current or planned operations in adjacent bands. In order to protect existing services adjacent to the AWS-4 allocation, interference limits would be set higher than the interference caused by existing operations; thus, transmissions by incumbent neighbors would not exceed the interference limit, and would not trigger a harmful interference claim by AWS-4 licensees. Existing operations would be "grandfathered in."

Where the adjacent band is currently quiet and the Commission expects that it may allocate it to more intensive use in future, the interference limit can be set significantly higher than current signal levels, thus allowing such a future allocation to be made without harmful interference to AWS-4 licensees (i.e. signals above their interference limit).

V. Receiver performance mandates are not needed in the AWS-4 service

Since the FCC contemplates allocating AWS-4 licenses by auction, we do not believe that mandatory receiver performance requirements ("receiver standards") are necessary in this case. It will be sufficient to specify interference limits that represent an upper bound on the

[17] Taher, T. M., Bacchus, R. B., Zdunek, K. J., and Roberson, D. A., *Long-term spectral occupancy findings in Chicago*. In 2011 IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN), pages 100-107, Figure 4, (2011).

interference that will be generated by services that are now or may in future be deployed in adjacent bands. AWS-4 licensees can then use this information to design receivers appropriate to their service model. If a dispute does arise, efficient resolution will be facilitated by the relatively low number of licensees on either side of the band boundary, combined with the explicit statement of harmful interference criteria in the interference limits.

VI. Conclusion

Radio regulation should take receivers as well as transmitters into account in order to maximize the value of radio operations. In the case of the AWS-4 allocation, it will be sufficient for the rules to specify interference limits below which licensees may not claim harmful interference, and leave device performance requirements, a.k.a. receiver standards, to manufacturers, operators and customers.